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FORM PTO 1390 (REV 11-2000) U S DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE		ATTORNEY'S DOCKET NUMBER LAGROTH-028
TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371		U.S APPLICATION NO. (If known, see 37 CFR 1.5) 10/018126
INTERNATIONAL APPLICATION NO. PCT/SE00/01257	INTERNATIONAL FILING DATES 15 June 2000	PRIORITY DATE CLAIMED 17 June 1999

TITLE OF INVENTION METHOD AND MEANS FOR MEASURING STRESS FORCES IN REFINERS

APPLICANT(S) FOR DO/EO/US Hans-Olof Backlund

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. [x] This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. [ ] This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing 35 U.S.C. 371
3. [x] This is an express request to begin national examination procedures (35 U.S.C. 371 (f)). The submission must include items (5), (6), (9) and (21) indicated below.
4. [x] The US has been elected by the expiration of 19 months from the priority date (PCT Article 31).
5. [x] A copy of the International Application as filed (35 U.S.C 371 (c)(2))
   - a. [ ] is attached hereto (required only if not communicated by the International Bureau).
   - b. [x] has been communicated by the International Bureau.
   - c. [ ] is not required, as the application was filed in the United States Receiving Office (RO/US).
6. [ ] An English language translation of the International Application as filed (35 U.S.C. 371 (c)(2)).
   - a [ ] is attached hereto.
   - b. [ ] has been previously submitted under 35 U.S.C. 154(d)(4).
7. [x] Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371 (c)(3))
   - a. [ ] are attached hereto (required only if not communicated by the International Bureau).
   - b. [ ] have been communicated by the International Bureau.
   - c. [ ] have not been made; however, the time limit for making such amendments has NOT expired.
   - d [x] have not been made and will not be made.
8. [ ] An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371 (c)(3)).
9. [x] An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)). (Executed)
10. [ ] An English language translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)).

Items 11 to 20 below concern document(s) or information included:

11. [x] An Information Disclosure Statement under 37 CFR 1.97 and 1.98. w/PTO-1449, 2 references
12. [x] An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. [x] A FIRST preliminary amendment.
14. [ ] A SECOND or SUBSEQUENT preliminary amendment.
15. [x] A substitute specification.
16. [ ] A change of power of attorney and/or address letter.
17. [ ] A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825.
18. [x] A second copy of the published international application under 35 U.S.C. 154(d)(4).
19. [ ] A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
20. [x] Other items or information: Substitute Abstract, Marked-up copy of specification, Copy of International Preliminary Examination Report, Two (2) Sheets of Formal Drawings

JC13 Rec'd PCT/PTO 12 DEC 2001

U.S. APPLICATION NO. (if known, see 37 CFR 1.5) 10/018126	INTERNATIONAL APPLICATION NO PCT/SE00/01257	ATTORNEY'S DOCKET NUMBER LAGROTH-028

17. [x] The following fees are submitted:

CALCULATIONS PTO USE ONLY

BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) – (5)):

- [x] Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO $1040.00
- [ ] International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO $890 00
- [ ] International preliminary examination fee (37 CFR 1 482) not paid to USPTO but international search fee (37 CFR 1 445(a)(2)) paid to USPTO . . . $740.00
- [ ] International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) $710.00
- [ ] International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4) . $100 00

ENTER APPROPRIATE BASIC FEE AMOUNT =				$ 1,040.00
Surcharge of $ ______ for furnishing the oath or declaration later than [ ] 20 [ ] 30 months from the earliest claimed priority date (37 CFR 1.492 (e)).				$
CLAIMS	**NUMBER FILED**	**NUMBER EXTRA**	**RATE**	
Total claims	*15-20 =		x	$ 0.00
Independent claims	2-3 =		x	$ 0.00
MULTIPLE DEPENDENT CLAIM(s) (if applicable)			+	$
TOTAL OF ABOVE CALCULATIONS =				$ 1,040.00
[ ] Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by ½.				$
SUBTOTAL =				$ 1,040.00
Processing fee of $ ______ for furnishing the English translation later than [ ] 20 [ ] 30 months from the earliest claimed priority date (37 CFR 1.492 (f)). +				$
TOTAL NATIONAL FEE =				$ 1,040.00
Fee for recording the enclosed assignment (37 CFR 1.21 (h)). Assignment must be accompanied by appropriate cover sheet (37 CFR 3.28, 3.31) (per property). +				$
TOTAL FEES ENCLOSED =				$ 1,040.00

*As In Preliminary Amendment

Amount to be Refunded:	**$**
Charged:	**$**

a. [ ] A check in the amount of $ ______ to cover the above fees is enclosed.

b. [x] Please charge my Deposit Account No. 12-1095 in the amount of $ 1,040.00 to cover the above fees. A duplicate copy of this sheet is enclosed.

c. [x] The Commissioner is hereby authorized to charge any additional fees which may be required or credit any overpayment to my Deposit Account No. 12-1095. A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137 (a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO

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SIGNATURE

Arnold H. Krumholz
NAME

25,428
REGISTRATION NUMBER

10018126 .121201

PATENT
LAGROTH 3.3-028

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of Hans-Olof BACKLUND	Group Art Unit:
International Application No. PCT/SE00/01257	Examiner:
International Filing Date: 15 June 2000	Date: December 12, 2001
For: A METHOD AND MEANS FOR MEASURING STRESS FORCES IN REFINERS	

Commissioner for Patents
Washington, D.C. 20231

PRELIMINARY AMENDMENT

Sir:

Preliminary to initiation of the prosecution of the above-identified pending U.S. patent application, the following amendments and remarks are respectfully submitted.

IN THE ABSTRACT

Please delete the Abstract as filed and substitute therefor the attached revised Abstract.

IN THE SPECIFICATION

Please amend the Specification in accordance with the attached revised Specification.

IN THE CLAIMS

Please cancel claims 1-13 and add new claims 14-28.

14. (NEW) A method of measuring the stress forces in a refining disk having a refining surface including a plurality of refiner bars and employed in a refiner including a pair of refiner disks defining a refining gap therebetween, said method comprising providing a measuring surface comprising at least a portion of a plurality of said refiner bars, resiliently mounting said measuring surface in said refiner surface, and measuring said stress forces across said measuring surface.

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15. (NEW) The method of claim 14 wherein said resilient mounting of said measuring surface comprises resiliently journaling said measuring surface in a direction substantially parallel to said refining surface whereby said measuring surface is movable in said direction in response to a stress force with respect to a permanent force sensor connected to said measuring surface.

16. (NEW) The method of claim 14 including calculating the size and distribution of the output transferred to material passing through said refining gap based on said stress force measured by said measuring surface, and employing said calculation to control the refining process.

17. (NEW) Apparatus for measuring stress forces in a refining disk having a refining surface including a plurality of refiner bars utilized in connection with a pair of refining disks defining a refining gap therebetween, comprising at least one measuring member disposed on said refiner surface and including a measuring surface including at least a portion of a plurality of said refiner bars, and resilient mounting means for resiliently mounting said at least one measuring member on said refiner surface.

18. (NEW) The apparatus of claim 17 wherein said at least one measuring member comprises a plurality of measuring members.

19. (NEW) The apparatus of claim 17 wherein said at least one measuring member comprises a force sensor and a measuring body connecting said force sensor to said measuring surface.

20. (NEW) The apparatus of claim 19 wherein said force sensor is in abutment with said measuring body, and including attachment means for fixing said force sensor with respect to said measuring body.

21. (NEW) The apparatus of claim 20 wherein said resilient mounting means comprises mounting means for resiliently journaling said measuring surface in a direction substantially parallel to said refiner surface.

22. (NEW) The apparatus of claim 21 wherein said measuring surface is connected to said measuring body, and said measuring body extends from said measuring surface on the side of said force sensor so as to provide a measuring body extension, said measuring body extension including a joint portion where said measuring body is movable in a direction substantially parallel to said refiner surface.

23. (NEW) The apparatus of claim 22 wherein said measuring body has a substantially circular cross-section, and wherein said joint portion comprises a flattened portion of said measuring body disposed below said force sensor.

24. (NEW) The apparatus of claim 19 wherein said force sensor comprises a piezoelectric sensor.

25. (NEW) The apparatus of claim 17 wherein said resilient mounting means comprises a sealing member surrounding said measuring surface for joining said measuring surface to said refiner surface.

26. (NEW) The apparatus of claim 25 wherein said sealing member comprises a yieldable material.

27. (NEW) The apparatus of claim 26 including a casing surrounding said force sensor and said measuring body, said attachment means attaching said force sensor to said casing, said measuring body including a first end and a second end, said first end of said measuring body attached to said casing and said second end of said measuring body attached to said measuring surface, said measuring surface and said sealing member closing said casing.

28. (NEW) The apparatus of claim 27 including a sleeve enclosing said sealing means, whereby said sleeve, said sealing means and said measuring surface are inserted in said casing when said casing is sealed.

REMARKS

The above-noted cancellation of claims 1-13, and addition of new claims 14-28, as well as the submission of a new Abstract and revisions to the Specification, are respectfully

submitted prior to initiation of the prosecution of this application in the U.S. Patent and Trademark Office.

The above-noted new claims are respectfully submitted in order to more clearly and appropriately claim the subject matter which applicants consider to constitute their inventive contribution. No new matter is included in these amendments. In addition, the revisions to the Abstract and Specification are submitted in order to clarify and correct the Abstract and Specification and to conform them to all of the requirements of U.S. practice. No new matter is included in these amendments.

In view of the above, it is respectfully requested that these amendments now be entered, and that prosecution on the merits of this application now be initiated. If, however, for any reason the Examiner does not believe such action can be taken, it is respectfully requested that he telephone applicant's attorney at (908) 654-5000 in order to overcome any objections which he may have.

If there are any additional charges in connection with this requested amendment, the Examiner is authorized to charge applicant's Deposit Account No. 12-1095 therefor.

Respectfully submitted,

LERNER, DAVID, LITTENBERG,
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A METHOD AND MEANS FOR MEASURING STRESS FORCES IN REFINERS

FIELD OF THE INVENTION

[0001] The present invention relates to a method and a measuring device for measuring stress forces in refiners having refining discs that between them define a refining gap for refining material.

BACKGROUND OF THE INVENTION

[0002] ~~Such refiners are using~~ Refiners such as those noted above are used for refining material containing fiber. The refiner generally comprises refining members in the form of ~~discs~~ disks which rotate in relation to each other and between which the material for refining passes from the inner periphery of the refining members, where the material is supplied, to the outer periphery of the refining members, through a refining gap formed between the refining members. Often one of the refining ~~discs~~ disks is fixed whereas the other rotates. The refining ~~discs~~ disks are generally constructed from segments provided with bars on their surface. The inner segments can then have a coarser pattern and the outer segments a finer pattern in order to produce fine refining of the material.

[0003] To ensure high quality when refining material containing fiber, the disturbances in operating conditions that continually occur for various reasons must be corrected by constant control of the various refining parameters to optimum values. This can be achieved by altering the supply of water, for instance, so that a larger or smaller cooling effect is obtained, by changing the flow of material for refining, by adjusting the distance between the refining members, or by a combination of these measures. Accurate determination of the energy transferred to the material for refining, and also of the distribution of the energy over the surface of the refining members, are necessary to enable the necessary adjustments and corrections to be performed.

[0004] To determine the energy/output transferred to the material for refining, it is ~~already~~ known to try to measure

the shear forces appearing in the refining zone. What is known as a shear force occurs when two surfaces move in relation to each other with a viscous liquid between the surfaces. Such a shear force is also created in a refiner used for refining wood chips mixed with water. It may be imagined that the chips of wood are both sheared and rolled between the refining discs, as well as colliding with each other and with the bars. The shear force is caused, *inter alia*, by the combined force of the discs and by the ~~friction~~ coefficient of friction. The normal force exerted on the surface also varies with the radius.

[0005] ~~Through SE-C-504801~~ As shown in Swedish Patent Application No. 504,801, a measuring device is ~~already~~ known comprising a special sensor bar, i.e. a bar provided with sensors which sense the load exerted on the sensor bar during refining, at a number of measuring points along the bar. However, the drawback of this arrangement is that measuring is only performed on occasional bars, and the result is therefore unreliable. Furthermore, the type of transducer, or strain gauge, used in bar experiments have a short service life since the transducers are located close to the refining surface and the material used to screen the transducers from steam and pulp is subjected to an extremely demanding environment. However, despite these drawbacks, strain gauges must be used because of the design of this measuring device.

[0006] ~~The~~ One object of the present invention is to solve the problems mentioned above and, first of all, to provide a method and a measuring device that produces a more reliable result than previously known devices, and also to provide a device with potential for a longer service life than previously known devices, thus making it more economical.

~~This object is achieved by a method as defined in claim 1 and with the characteristics specified therein, and also with a measuring device as defined in claim 4.~~

SUMMARY OF THE INVENTION

[0007] In accordance with the present invention, these and other objects have now been realized by the invention of a method of measuring the stress forces in a refining disk having a refining surface including a plurality of refiner bars and employed in a refiner including a pair of refiner disks defining a refining gap therebetween, the method comprising providing a measuring surface comprising at least a portion of a plurality of the refiner bars, resiliently mounting the measuring surface in the refiner surface, and measuring the stress forces across the measuring surface. Preferably, the resilient mounting of the measuring surface comprises resiliently journaling the measuring surface in a direction substantially parallel to the refining surface whereby the measuring surface is movable in the direction in response to a stress force with respect to a permanent force sensor connected to the measuring surface.

[0008] In accordance with one embodiment of the method of the present invention, the method includes calculating the size and distribution of the output transferred to material passing through the refining gap based on the stress force measured by the measuring surface, and employing the calculation to control the refining process.

[0009] In accordance with the present invention, apparatus has also been discovered for measuring stress forces in a refining disk having a refining surface including a plurality of refiner bars utilized in connection with a pair of refining disks defining a refining gap therebetween, comprising at least one measuring member disposed on the refiner surface and including a measuring surface including at least a portion of a plurality of the refiner bars, and resilient mounting means for resiliently mounting the at least one measuring member on the refiner surface. Preferably, the at least one measuring member comprises a plurality of measuring members.

[0010] In accordance with one embodiment of the apparatus of the present invention, the at least one measuring member

comprises a force sensor and a measuring body connecting the force sensor to the measuring surface. Preferably, the force sensor is in abutment with the measuring body, and the apparatus includes attachment means for fixing the force sensor with respect to the measuring body. Preferably, the resilient mounting means comprises mounting means for resiliently journaling the measuring surface in a direction substantially parallel to the refiner surface.

[0011] In accordance with another embodiment of the apparatus of the present invention, the measuring surface is connected to the measuring body, and the measuring body extends from the measuring surface on the side of the force sensor so as to provide a measuring body extension, the measuring body extension including a joint portion where the measuring body is movable in a direction substantially parallel to the refiner surface. Preferably, the measuring body has a substantially circular cross-section, and the joint portion comprises a flattened portion of the measuring body disposed below the force sensor.

[0012] In accordance with one embodiment of the apparatus of the present invention, the force sensor comprises a piezoelectric sensor.

[0013] In accordance with another embodiment of the apparatus of the present invention, the resilient mounting means comprises a sealing member surrounding the measuring surface for joining the measuring surface to the refiner surface. Preferably, the sealing member comprises a yieldable material. In a preferred embodiment, the apparatus includes a casing surrounding the force sensor and the measuring body, the attachment means attaching the force sensor to the casing, the measuring body including a first end and a second end, the first end of the measuring body attached to the casing and the second end of the measuring body attached to the measuring surface, the measuring surface and the sealing member closing the casing. In a preferred embodiment, the apparatus includes a sleeve enclosing the sealing means, whereby the sleeve, the

sealing means and the measuring surface are inserted in the casing when the casing is sealed.

[0014] ~~The~~ According to the method ~~is thus characterised in that~~ of the present invention, measurement of the force stress is performed across a measuring surface constituting a part of a refining ~~disc~~disk, ~~said~~ the measuring surface comprising at least parts of more than one bar and being resiliently mounted in relation to the surface of the refining ~~disc~~ disk. The measuring device is provided with corresponding means for performing the method. The present invention thus reveals the advantage that, in comparison with known technology, measurement of the stress force is performed over a relatively large surface, thereby producing a considerably more reliable result.

[0015] According to a preferred embodiment of the present invention, measurement is performed by the measuring surface being resiliently journalled in a direction parallel with the surface of the refining ~~disc~~ disk and being movable in said direction in the event of a stress force, in relation to a rigidly mounted force sensor with which the measuring surface is connected, ~~said~~ the force sensor thus being influenced by and measuring ~~said~~ the stress force. The measuring device in turn reveals features comprising equivalent members.

[0016] According to a particularly preferred feature of the present invention, ~~therefore,~~ the measuring device comprises a force sensor and a body connecting the sensor with the measuring surface. Through this arrangement the present invention achieves the advantage that the force stress is measured directly, instead of indirectly by measurement of linear strain and the like, as occurs with known technology.

[0017] The sensor, which is preferably a piezoelectric force sensor constructed of quartz crystal (a "quartz sensor") also contributes to an extremely rigid measuring device being possible. The preferred sensor will withstand temperatures of up to about 200°C and is also linear up to this temperature.

[0018] In accordance with another preferred feature of the present invention, the measuring surface is connected to ~~said~~ the body and the part of ~~said~~ the body that extends on the side of the force sensor opposite to the measuring surface~~,~~ is provided with a joint where the body is movable in a direction substantially parallel with the surface of the refining ~~disc~~ disk. However, as mentioned above, since the force sensor has a relatively stiff spring action, the shear forces will only cause extremely small movements in the joint, and thus the measuring device. This makes it easier to seal the measuring device against steam and wood chips penetrating from the surroundings, neither will it be as sensitive to material that accumulates around the measuring device. These are important advantages over the known technology. In the direction perpendicular to the measuring surface, the body has such a high degree of rigidity that no changes will occur in the refining gap, which is another advantage.

~~Additional advantages and features of the invention are revealed in the sub-claims.~~

~~The present invention will now be described with reference to the embodiment illustrated in the accompanying drawings, in which~~

~~Figure 1 shows a view in perspective of a refining segment forming part of a refining disc, provided with measuring devices in accordance with the present invention;~~

~~Figure 2 shows a basic layout sketch of a measuring device in accordance with the present invention;~~

~~Figures 3a and 3b illustrate the force ratio applicable for the invention; and~~

~~Figure 4 shows a view, partly in section, of a measuring device in accordance with the present invention.~~

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] The present invention will now be more fully described with reference to the following detailed description which, in turn, refers to the accompanying drawings, in which:

[0020] Figure 1 is a front, perspective view of a refining segment forming part of a refining disk provided with measuring devices in accordance with the present invention;

[0021] Figure 2 is a side, elevational, schematic representation of a basic layout of a measuring device in accordance with the present invention;

[0022] Figure 3a is a schematic representation showing the force ratio applicable to the present invention;

[0023] Figure 3b is a schematic representation showing the force ratio applicable to the present invention; and

[0024] Figure 4 is a side, elevational, partially sectional view of a measuring device in accordance with the present invention.

DETAILED DESCRIPTION

[0025] Figure 1 ~~thus~~ illustrates a part of a refining ~~disc~~ disk in the form of a refining segment 1, provided with a pattern comprising a number of bars 3 extending in a substantially radial direction. Measuring devices 5, in accordance with the present invention, are also illustrated schematically in ~~this~~ figure 1. These measuring devices preferably have a circular measuring surface, with a diameter ~~in~~ on the order of magnitude of 30 mm, for instance, but the measuring surface may also have a different geometric shape. The measuring devices are preferably arranged at different radial distances from the ~~centre~~ center of the refining ~~disc~~ disk, and segments at different distances from the ~~centre~~ center are also preferably provided with measuring devices. It is also advantageous for the measuring devices to be staggered peripherally in relation to each other, all with the object of being ~~able~~ better able to determine the force distribution in the refiner and thus for better ~~to~~ control of the refining process. When a measuring device is affected by a force parallel with the surface of the refining ~~disc~~disk/segment, the force sensor of the measuring device will generate a signal that is proportional to the load.

[0026] The measuring device according to the present invention functions in accordance with the principle illustrated in figure 2. A ~~disc~~ disk segment 1 can be seen here from the side, equipped with bars 3. A measuring device 5 is also visible, comprising a part of the surface of the ~~disc~~ disk segment and being provided with a number of bars 6, or at least parts thereof. When the refining ~~disc~~ disk is subjected to a shear load F, the measuring device 5 (the sensor) will take up a load F_m which is denoted by the following expression:

$$F_m = F \cdot \frac{l_1}{l_2} \quad (1)$$

where l_2 is the distance between the point where a sensor 10 in the measuring device is secured and the joint 8 of the device, and where l_1 is the distance between the measuring surface 7 of the measuring device and the joint 8. This formula is valid provided the joint does not take up any torque, and that the pressure distribution over the measuring surface 7 subjected to the shear force is not too uneven. The joint 8 consists in principle of a metal sheet of such small thickness so as to ~~give~~ provide a negligible contribution to the total stiffness of the measuring device, while at the same time being able to withstand the loads to which it is subjected. The thickness of the metal sheet can at the same time be rather large since the sensor itself is relatively rigid, giving little flexure in the sheet. The dimension of the joint 8 ~~shall~~ is thus ~~be~~ adjusted to withstand the vertical load occurring, while at the same time absorbing only a negligible part of the lateral load that the screw and the sensor ~~shall~~ absorb. See also the detailed description in conjunction with figure 4.

[0027] The model in figures 3a and 3b describes how high and low rigidity, respectively, affect the function of the measuring device, through the rigidity that sensor, attachment screw (the attachment member by which the sensor is fixed in relation to the measuring surface and the body, see Fig. 4)

and the joint possess. The force and the torque absorbed by the sensor/attachment screw and the joint, respectively, are controlled by the ratio $F_{sensor} = k_2 \cdot \delta$ and $M = k_3 \cdot \Delta\varphi$, where M is the torque in the joint. k_2 is in this case the rigidity of the spring 15, that is to say the sensor 10 together with the attachment screw 20, and k_3 is the rigidity of the journaling point/joint 8. The ratio shows clearly that if F = constant and k_2 increases, then δ will decrease, and thus also M, since the torque is directly proportional to the flexure δ for small angles. In the case under discussion k_2 is large and the equation (1) is therefore valid.

[0028] It should be pointed out that, in this case, relatively high rigidity of the sensor/attachment screw results in high rigidity in relation to the load that the sensor/screw ~~shall~~ absorbs. The load may vary greatly across the refining zone, *e.g.* from an order of magnitude of 20N to an order of magnitude of 150N. In the present case, with an estimated average value of about 40N, displacements of the measuring surface are obtained that can be measured in hundredths of a ~~millimetre~~millimeter. As mentioned ~~earlier~~ above, these minor displacements facilitate sealing the device from the surrounding environment. As ~~to~~ for the body 17, this can be considered as completely rigid in the direction perpendicular to the measuring surface.

[0029] Figure 4 shows a preferred embodiment of a measuring device in accordance with the present invention. The measuring device 5 comprises a measuring surface 7 provided with bars 6, or parts of bars, which measuring surface constitutes a part of a ~~disc~~ disk segment as illustrated in figure 1. As can also be seen in figure 1, the measuring device ~~has a~~ preferably has a circular measuring surface.

[0030] The measuring surface 7 is in direct contact with a body 17, preferably of steel, extending inside the device. The measuring surface is preferably screwed to the body 17. Slightly below the measuring surface the body 17 is provided

with a transverse recess in which a force sensor 10 is arranged, preferably a quartz sensor. Here, too, the body 17 is provided with a through hole in which an attachment screw 20 is applied, passing through the hole and securing the sensor 10. The sensor 10 is thus fixed in relation to the body 17 by means of the screw 20, as will be described below. Other attachment means for the sensor 10 are ~~naturally~~ possible. Otherwise, the body 17 preferably has a circular cross section. Further down beneath the sensor, the body 17 assumes a narrowing, flattened shape in an area corresponding to the joint 8, mentioned ~~earlier~~ above, and described in conjunction with figures 2, 3a and 3b.

[0031] The sensor 10 and the body 17 are ~~arranged~~ disposed inside a protective casing 22. This casing has an opening at the top, adjacent to the surrounding refining segment, which is closed by the measuring surface 7, a seal 12 surrounding the measuring surface, and a sleeve 13 in which the seal is ~~arranged~~ disposed. The seal 12 is of a particularly suitable, somewhat yielding material such as rubber, so that it can permit the small movements that the shear forces give rise to in the measuring surface, and still achieve a good seal that prevents steam and pulp from penetrating into the device. The seal preferably has a dampening effect as regards, ***inter alia***, the vibrations that occur during operation. The purpose of the sleeve 13 is primarily to facilitate sealing of the measuring device since the measuring surface and the seal are first assembled in the sleeve which can then easily be inserted partially into the casing 22. Naturally, it is possible to omit the sleeve.

[0032] The casing 22 also has a function in securing the sensor 10 in relation to the measuring surface 7. The sensor is thus secured in the casing by means of the attachment screw 20. Finally, the body 17 is attached in the casing at the end opposite to the measuring surface.

~~The invention is not limited to the embodiment illustrated in the drawings. It can be modified and altered in many ways~~

~~obvious to one skilled in the art, within the scope of the appended claims.~~

[0033] Although the invention herein has been described with reference to particular embodiments, it is to be understood that these embodiments are merely illustrative of the principles and applications of the present invention. It is therefore to be understood that numerous modifications may be made to the illustrative embodiments and that other arrangements may be devised without departing from the spirit and scope of the present invention as defined by the appended claims.

341620_1.DOC

Substitute Specification

2/prts

10/018126
JC13 Rec'd PCT/PTC 12 DEC 2001

A METHOD AND MEANS FOR MEASURING STRESS FORCES IN REFINERS

FIELD OF THE INVENTION

[0001] The present invention relates to a method and a measuring device for measuring stress forces in refiners having refining discs that between them define a refining gap for refining material.

BACKGROUND OF THE INVENTION

[0002] Refiners such as those noted above are used for refining material containing fiber. The refiner generally comprises refining members in the form of disks which rotate in relation to each other and between which the material for refining passes from the inner periphery of the refining members, where the material is supplied, to the outer periphery of the refining members, through a refining gap formed between the refining members. Often one of the refining disks is fixed whereas the other rotates. The refining disks are generally constructed from segments provided with bars on their surface. The inner segments can then have a coarser pattern and the outer segments a finer pattern in order to produce fine refining of the material.

[0003] To ensure high quality when refining material containing fiber, the disturbances in operating conditions that continually occur for various reasons must be corrected by constant control of the various refining parameters to optimum values. This can be achieved by altering the supply of water, for instance, so that a larger or smaller cooling effect is obtained, by changing the flow of material for refining, by adjusting the distance between the refining members, or by a combination of these measures. Accurate determination of the energy transferred to the material for refining, and also of the distribution of the energy over the surface of the refining members, are necessary to enable the necessary adjustments and corrections to be performed.

[0004] To determine the energy/output transferred to the material for refining, it is known to try to measure the shear forces appearing in the refining zone. What is known as a

shear force occurs when two surfaces move in relation to each other with a viscous liquid between the surfaces. Such a shear force is also created in a refiner used for refining wood chips mixed with water. It may be imagined that the chips of wood are both sheared and rolled between the refining discs, as well as colliding with each other and with the bars. The shear force is caused, *inter alia*, by the combined force of the discs and by the coefficient of friction. The normal force exerted on the surface also varies with the radius.

[0005] As shown in Swedish Patent Application No. 504,801, a measuring device is known comprising a special sensor bar, i.e. a bar provided with sensors which sense the load exerted on the sensor bar during refining, at a number of measuring points along the bar. However, the drawback of this arrangement is that measuring is only performed on occasional bars, and the result is therefore unreliable. Furthermore, the type of transducer, or strain gauge, used in bar experiments have a short service life since the transducers are located close to the refining surface and the material used to screen the transducers from steam and pulp is subjected to an extremely demanding environment. However, despite these drawbacks, strain gauges must be used because of the design of this measuring device.

[0006] One object of the present invention is to solve the problems mentioned above and, first of all, to provide a method and a measuring device that produces a more reliable result than previously known devices, and also to provide a device with potential for a longer service life than previously known devices, thus making it more economical.

SUMMARY OF THE INVENTION

[0007] In accordance with the present invention, these and other objects have now been realized by the invention of a method of measuring the stress forces in a refining disk having a refining surface including a plurality of refiner bars and employed in a refiner including a pair of refiner disks defining a refining gap therebetween, the method

comprising providing a measuring surface comprising at least a portion of a plurality of the refiner bars, resiliently mounting the measuring surface in the refiner surface, and measuring the stress forces across the measuring surface. Preferably, the resilient mounting of the measuring surface comprises resiliently journaling the measuring surface in a direction substantially parallel to the refining surface whereby the measuring surface is movable in the direction in response to a stress force with respect to a permanent force sensor connected to the measuring surface.

[0008] In accordance with one embodiment of the method of the present invention, the method includes calculating the size and distribution of the output transferred to material passing through the refining gap based on the stress force measured by the measuring surface, and employing the calculation to control the refining process.

[0009] In accordance with the present invention, apparatus has also been discovered for measuring stress forces in a refining disk having a refining surface including a plurality of refiner bars utilized in connection with a pair of refining disks defining a refining gap therebetween, comprising at least one measuring member disposed on the refiner surface and including a measuring surface including at least a portion of a plurality of the refiner bars, and resilient mounting means for resiliently mounting the at least one measuring member on the refiner surface. Preferably, the at least one measuring member comprises a plurality of measuring members.

[0010] In accordance with one embodiment of the apparatus of the present invention, the at least one measuring member comprises a force sensor and a measuring body connecting the force sensor to the measuring surface. Preferably, the force sensor is in abutment with the measuring body, and the apparatus includes attachment means for fixing the force sensor with respect to the measuring body. Preferably, the resilient mounting means comprises mounting means for

resiliently journaling the measuring surface in a direction substantially parallel to the refiner surface.

[0011] In accordance with another embodiment of the apparatus of the present invention, the measuring surface is connected to the measuring body, and the measuring body extends from the measuring surface on the side of the force sensor so as to provide a measuring body extension, the measuring body extension including a joint portion where the measuring body is movable in a direction substantially parallel to the refiner surface. Preferably, the measuring body has a substantially circular cross-section, and the joint portion comprises a flattened portion of the measuring body disposed below the force sensor.

[0012] In accordance with one embodiment of the apparatus of the present invention, the force sensor comprises a piezoelectric sensor.

[0013] In accordance with another embodiment of the apparatus of the present invention, the resilient mounting means comprises a sealing member surrounding the measuring surface for joining the measuring surface to the refiner surface. Preferably, the sealing member comprises a yieldable material. In a preferred embodiment, the apparatus includes a casing surrounding the force sensor and the measuring body, the attachment means attaching the force sensor to the casing, the measuring body including a first end and a second end, the first end of the measuring body attached to the casing and the second end of the measuring body attached to the measuring surface, the measuring surface and the sealing member closing the casing. In a preferred embodiment, the apparatus includes a sleeve enclosing the sealing means, whereby the sleeve, the sealing means and the measuring surface are inserted in the casing when the casing is sealed.

[0014] According to the method of the present invention, measurement of the force stress is performed across a measuring surface constituting a part of a refiningdisk, the measuring surface comprising at least parts of more than one bar and

being resiliently mounted in relation to the surface of the refining disk. The measuring device is provided with corresponding means for performing the method. The present invention thus reveals the advantage that, in comparison with known technology, measurement of the stress force is performed over a relatively large surface, thereby producing a considerably more reliable result.

[0015] According to a preferred embodiment of the present invention, measurement is performed by the measuring surface being resiliently journalled in a direction parallel with the surface of the refining disk and being movable in said direction in the event of a stress force, in relation to a rigidly mounted force sensor with which the measuring surface is connected, the force sensor thus being influenced by and measuring the stress force. The measuring device in turn reveals features comprising equivalent members.

[0016] According to a particularly preferred feature of the present invention, the measuring device comprises a force sensor and a body connecting the sensor with the measuring surface. Through this arrangement the present invention achieves the advantage that the force stress is measured directly, instead of indirectly by measurement of linear strain and the like, as occurs with known technology.

[0017] The sensor, which is preferably a piezoelectric force sensor constructed of quartz crystal (a "quartz sensor") also contributes to an extremely rigid measuring device being possible. The preferred sensor will withstand temperatures of up to about 200°C and is also linear up to this temperature.

[0018] In accordance with another preferred feature of the present invention, the measuring surface is connected to the body and the part of the body that extends on the side of the force sensor opposite to the measuring surface is provided with a joint where the body is movable in a direction substantially parallel with the surface of the refining disk. However, as mentioned above, since the force sensor has a relatively stiff spring action, the shear forces will only cause

extremely small movements in the joint, and thus the measuring device. This makes it easier to seal the measuring device against steam and wood chips penetrating from the surroundings, neither will it be as sensitive to material that accumulates around the measuring device. These are important advantages over the known technology. In the direction perpendicular to the measuring surface, the body has such a high degree of rigidity that no changes will occur in the refining gap, which is another advantage.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] The present invention will now be more fully described with reference to the following detailed description which, in turn, refers to the accompanying drawings, in which:

[0020] Figure 1 is a front, perspective view of a refining segment forming part of a refining disk provided with measuring devices in accordance with the present invention;

[0021] Figure 2 is a side, elevational, schematic representation of a basic layout of a measuring device in accordance with the present invention;

[0022] Figure 3a is a schematic representation showing the force ratio applicable to the present invention;

[0023] Figure 3b is a schematic representation showing the force ratio applicable to the present invention; and

[0024] Figure 4 is a side, elevational, partially sectional view of a measuring device in accordance with the present invention.

DETAILED DESCRIPTION

[0025] Figure 1 illustrates a part of a refining disk in the form of a refining segment 1, provided with a pattern comprising a number of bars 3 extending in a substantially radial direction. Measuring devices 5, in accordance with the present invention, are also illustrated schematically in figure 1. These measuring devices preferably have a circular measuring surface, with a diameter on the order of magnitude of 30 mm, for instance, but the measuring surface may also have a different geometric shape. The measuring devices are preferably

arranged at different radial distances from the center of the refining disk, and segments at different distances from the center are also preferably provided with measuring devices. It is also advantageous for the measuring devices to be staggered peripherally in relation to each other, all with the object of being better able to determine the force distribution in the refiner and thus for better control of the refining process. When a measuring device is affected by a force parallel with the surface of the refining disk/segment, the force sensor of the measuring device will generate a signal that is proportional to the load.

[0026] The measuring device according to the present invention functions in accordance with the principle illustrated in figure 2. A disk segment 1 can be seen here from the side, equipped with bars 3. A measuring device 5 is also visible, comprising a part of the surface of the disk segment and being provided with a number of bars 6, or at least parts thereof. When the refining disk is subjected to a shear load F, the measuring device 5 (the sensor) will take up a load F_m which is denoted by the following expression:

$$F_m = F \cdot \frac{l_1}{l_2} \quad (1)$$

where l_2 is the distance between the point where a sensor 10 in the measuring device is secured and the joint 8 of the device, and where l_1 is the distance between the measuring surface 7 of the measuring device and the joint 8. This formula is valid provided the joint does not take up any torque, and that the pressure distribution over the measuring surface 7 subjected to the shear force is not too uneven. The joint 8 consists in principle of a metal sheet of such small thickness so as to provide a negligible contribution to the total stiffness of the measuring device, while at the same time being able to withstand the loads to which it is subjected. The thickness of the metal sheet can at the same time be rather large since the sensor itself is relatively rigid, giving little flexure in

the sheet. The dimension of the joint 8 is thus adjusted to withstand the vertical load occurring, while at the same time absorbing only a negligible part of the lateral load that the screw and the sensor absorb. See also the detailed description in conjunction with figure 4.

[0027] The model in figures 3a and 3b describes how high and low rigidity, respectively, affect the function of the measuring device, through the rigidity that sensor, attachment screw (the attachment member by which the sensor is fixed in relation to the measuring surface and the body, see Fig. 4) and the joint possess. The force and the torque absorbed by the sensor/attachment screw and the joint, respectively, are controlled by the ratio $F_{sensor} = k_2 \cdot \delta$ and $M = k_3 \cdot \Delta\varphi$, where M is the torque in the joint. k_2 is in this case the rigidity of the spring 15, that is to say the sensor 10 together with the attachment screw 20, and k_3 is the rigidity of the journaling point/joint 8. The ratio shows clearly that if F = constant and k_2 increases, then δ will decrease, and thus also M, since the torque is directly proportional to the flexure δ for small angles. In the case under discussion k_2 is large and the equation (1) is therefore valid.

[0028] It should be pointed out that, in this case, relatively high rigidity of the sensor/attachment screw results in high rigidity in relation to the load that the sensor/screw absorbs. The load may vary greatly across the refining zone, *e.g.* from an order of magnitude of 20N to an order of magnitude of 150N. In the present case, with an estimated average value of about 40N, displacements of the measuring surface are obtained that can be measured in hundredths of a millimeter. As mentioned above, these minor displacements facilitate sealing the device from the surrounding environment. As for the body 17, this can be considered as completely rigid in the direction perpendicular to the measuring surface.

[0029] Figure 4 shows a preferred embodiment of a measuring device in accordance with the present invention. The measuring

device 5 comprises a measuring surface 7 provided with bars 6, or parts of bars, which measuring surface constitutes a part of a disk segment as illustrated in figure 1. As can also be seen in figure 1, the measuring device preferably has a circular measuring surface.

[0030] The measuring surface 7 is in direct contact with a body 17, preferably of steel, extending inside the device. The measuring surface is preferably screwed to the body 17. Slightly below the measuring surface the body 17 is provided with a transverse recess in which a force sensor 10 is arranged, preferably a quartz sensor. Here, too, the body 17 is provided with a through hole in which an attachment screw 20 is applied, passing through the hole and securing the sensor 10. The sensor 10 is thus fixed in relation to the body 17 by means of the screw 20, as will be described below. Other attachment means for the sensor 10 are possible. Otherwise, the body 17 preferably has a circular cross section. Further down beneath the sensor, the body 17 assumes a narrowing, flattened shape in an area corresponding to the joint 8, mentioned above, and described in conjunction with figures 2, 3a and 3b.

[0031] The sensor 10 and the body 17 are disposed inside a protective casing 22. This casing has an opening at the top, adjacent to the surrounding refining segment, which is closed by the measuring surface 7, a seal 12 surrounding the measuring surface, and a sleeve 13 in which the seal is disposed. The seal 12 is of a particularly suitable, somewhat yielding material such as rubber, so that it can permit the small movements that the shear forces give rise to in the measuring surface, and still achieve a good seal that prevents steam and pulp from penetrating into the device. The seal preferably has a dampening effect as regards, *inter alia*, the vibrations that occur during operation. The purpose of the sleeve 13 is primarily to facilitate sealing of the measuring device since the measuring surface and the seal are first assembled in the sleeve which can then easily be inserted partially into the casing 22. Naturally, it is possible to omit the sleeve.

[0032] The casing 22 also has a function in securing the sensor 10 in relation to the measuring surface 7. The sensor is thus secured in the casing by means of the attachment screw 20. Finally, the body 17 is attached in the casing at the end opposite to the measuring surface.

[0033] Although the invention herein has been described with reference to particular embodiments, it is to be understood that these embodiments are merely illustrative of the principles and applications of the present invention. It is therefore to be understood that numerous modifications may be made to the illustrative embodiments and that other arrangements may be devised without departing from the spirit and scope of the present invention as defined by the appended claims.

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ABSTRACT OF THE DISCLOSURE

Methods and apparatus for measuring the stress forces in refining disks are disclosed. The method includes providing a measuring surface comprising at least a portion of a plurality of refiner bars on the refining surface of a refining disk, resiliently mounting the measuring surface in the refiner surface, and measuring the stress forces across the measuring surface.

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A METHOD AND MEANS FOR MEASURING STRESS FORCES IN REFINERS

The present invention relates to a method and a measuring device for measuring stress forces in refiners having refining discs that between them define a refining gap for refining material.

Such refiners are using for refining material containing fiber. The refiner generally comprises refining members in the form of discs which rotate in relation to each other and between which the material for refining passes from the inner periphery of the refining members, where the material is supplied, to the outer periphery of the refining members, through a refining gap formed between the refining members. Often one of the refining discs is fixed whereas the other rotates. The refining discs are generally constructed from segments provided with bars. The inner segments then have a coarser pattern and the outer segments a finer pattern in order to produce fine refining of the material.

To ensure high quality when refining material containing fiber, the disturbances in operating conditions that continually occur for various reasons must be corrected by constant control of the various refining parameters to optimum values. This can be achieved by altering the supply of water, for instance, so that a larger or smaller cooling effect is obtained, by changing the flow of material for refining, by adjusting the distance between the refining members, or a combination of these measures. Accurate determination of the energy transferred to the material for refining, and also of the distribution of the energy over the surface of the refining members, are necessary to enable the necessary adjustments and corrections to be performed.

To determine the energy/output transferred to the material for refining, it is already known to try to measure the shear forces appearing in the refining zone. What is known as a shear force occurs when two surfaces move in relation to each other with a viscous liquid between the surfaces. Such a shear force is also created in a refiner used for refining wood chips mixed with water. It may be imagined that the chips of wood are both sheared and rolled between the refining discs, as well as colliding with each other and the bars. The shear force is caused, inter alia, by the combined force of the discs and by the friction coefficient. The normal force exerted on the surface also varies with the radius.

Through SE-C-504801 a measuring device is already known comprising a special sensor bar, i.e. a bar provided with sensors which sense the load exerted on the sensor bar during refining, at a number of measuring points along the bar. However, the drawback of this arrangement is that measuring is only performed on occasional bars and the result is therefore unreliable. Furthermore, the type of transducer, strain gauge, used in bar experiments have a short service life since

the transducers are located close to the refining surface and the material used to screen the transducers from steam and pulp is subjected to an extremely demanding environment. However, despite these drawbacks, strain gauges must be used because of the design of this measuring device.

The object of the present invention is to solve the problems mentioned above and, first of all, to provide a method and a measuring device that produces a more reliable result than previously known devices, and also to provide a device with potential for a longer service life than previously known devices, thus making it more economical.

This object is achieved by a method as defined in claim 1 and with the characteristics specified therein, and also with a measuring device as defined in claim 4.

The method is thus characterised in that measurement of the force stress is performed across a measuring surface constituting a part of a refining disc, said measuring surface comprising at least parts of more than one bar and being resiliently mounted in relation to the surface of the refining disc. The measuring device is provided with corresponding means for performing the method. The present invention thus reveals the advantage that, in comparison with known technology, measurement of the stress force is performed over a relatively large surface, thereby producing a considerably more reliable result.

According to a preferred embodiment, measurement is performed by the measuring surface being resiliently journalled in a direction parallel with the surface of the refining disc and being movable in said direction in the event of a stress force, in relation to a rigidly mounted force sensor with which the measuring surface is connected, said force sensor thus being influenced by and measuring said stress force. The measuring device in turn reveals features comprising equivalent members.

According to a particularly preferred feature, therefore, the measuring device comprises a force sensor and a body connecting the sensor with the measuring surface. Through this arrangement the present invention achieves the advantage that the force stress is measured directly, instead of indirectly by measurement of linear strain and the like, as occurs with known technology.

The sensor, which is preferably a piezoelectric force sensor constructed of quartz crystal (a "quartz sensor") also contributes to an extremely rigid measuring device being possible. The preferred sensor will withstand temperatures of up to 200^{o}C and is also linear up to this temperature.

In accordance with another preferred feature, the measuring surface is connected to said body and the part of said body that extends on the side of the

force sensor opposite to the measuring surface, is provided with a joint where the body is movable in a direction substantially parallel with the surface of the refining disc. However, as mentioned above, since the force sensor has a relatively stiff spring action, the shear forces will only cause extremely small movements in the joint, and thus the measuring device. This makes it easier to seal the measuring device against steam and wood chips penetrating from the surroundings, neither will it be as sensitive to material that accumulates around the measuring device. These are important advantages over the known technology. In the direction perpendicular to the measuring surface, the body has such a high degree of rigidity that no changes will occur in the refining gap, which is another advantage.

Additional advantages and features of the invention are revealed in the sub-claims.

The present invention will now be described with reference to the embodiment illustrated in the accompanying drawings, in which

Figure 1	shows a view in perspective of a refining segment forming part of a refining disc, provided with measuring devices in accordance with the present invention;
Figure 2	shows a basic layout sketch of a measuring device in accordance with the present invention;
Figures 3a and 3b	illustrate the force ratio applicable for the invention; and
Figure 4	shows a view, partly in section, of a measuring device in accordance with the present invention.

Figure 1 thus illustrates a part of a refining disc in the form of a refining segment 1, provided with a pattern comprising a number of bars 3 extending in substantially radial direction. Measuring devices 5, in accordance with the present invention, are also illustrated schematically in this figure. These measuring devices preferably have a circular measuring surface, with a diameter in the order of magnitude of 30 mm, for instance, but the measuring surface may also have a different geometric shape. The measuring devices are preferably arranged at different radial distances from the centre of the refining disc, and segments at different distances from the centre are also preferably provided with measuring devices. It is also advantageous for the measuring devices to be staggered peripherally in relation to each other, all with the object of being able better to determine the force distribution in the refiner and thus better to control the refining process. When a measuring device is affected by a force parallel with the surface of the refining disc/segment, the force sensor of the measuring device will generate a signal that is proportional to the load.

The measuring device according to the invention functions in accordance with the principle illustrated in figure 2. A disc segment 1 can be seen here from

the side, equipped with bars 3. A measuring device 5 is also visible, comprising a part of the surface of the disc segment and being provided with a number of bars 6, or at least parts thereof. When the refining disc is subjected to a shear load F, the measuring device 5 (the sensor) will take up a load F_m which is denoted by the following expression:

$$F_m = F \cdot \frac{l_1}{l_2} \qquad (1)$$

where l_2 is the distance between the point where a sensor 10 in the measuring device is secured and the joint 8 of the device, and where l_1 is the distance between the measuring surface 7 of the measuring device and the joint 8. This formula is valid provided the joint does not take up any torque, and that the pressure distribution over the measuring surface 7 subjected to the shear force is not too uneven. The joint 8 consists in principle of a metal sheet of such small thickness as to give a negligible contribution to the total stiffness of the measuring device while at the same time being able to withstand the loads to which it is subjected. The thickness of the metal sheet can at the same time be rather large since the sensor itself is relatively rigid, giving little flexure in the sheet. The dimension of the joint 8 shall thus be adjusted to withstand the vertical load occurring, while at the same time absorbing only a negligible part of the lateral load that the screw and the sensor shall absorb. See also the detailed description in conjunction with figure 4.

The model in figures 3a and 3b describes how high and low rigidity, respectively, affect the function of the measuring device, through the rigidity that sensor, attachment screw (the attachment member by which the sensor is fixed in relation to the measuring surface and the body, see Fig. 4) and joint possess. The force and the torque absorbed by the sensor/attachment screw and the joint, respectively, are controlled by the ratio $F_{sensor} = k_2 \cdot \delta$ and $M = k_3 \cdot \Delta\varphi$, where M is the torque in the joint. k_2 is in this case the rigidity of the spring 15, that is to say the sensor 10 together with the attachment screw 20, and k_3 is the rigidity of the journalling point/joint 8. The ratio shows clearly that if F = constant and k_2 increases, then δ will decrease, and thus also M since the torque is directly proportional to the flexure δ for small angles. In the case under discussion k_2 is large and the equation (1) is therefore valid.

It should be pointed out that, in this case, relatively high rigidity of the sensor/attachment screw results in high rigidity in relation to the load that the sensor/screw shall absorb. The load may vary greatly across the refining zone, e.g. from an order of magnitude of 20N to an order of magnitude of 150N. In the present case, with an estimated average value of about 40N, displacements of the measuring surface are obtained that can be measured in hundredths of a millimetre. As mentioned earlier, these minor displacements facilitate sealing the device from the surrounding environment. As to the body 17, this can be considered as completely rigid in the direction perpendicular to the measuring surface.

Figure 4 shows a preferred embodiment of a measuring device in accordance with the present invention. The measuring device 5 comprises a measuring surface 7 provided with bars 6, or parts of bars, which measuring surface constitutes a part of a disc segment as illustrated in figure 1. As can also be seen in figure 1, the measuring device has a preferably circular measuring surface.

The measuring surface 7 is in direct contact with a body 17, preferably of steel, extending inside the device. The measuring surface is preferably screwed to the body 17. Slightly below the measuring surface the body 17 is provided with a transverse recess in which a force sensor 10 is arranged, preferably a quartz sensor. Here, too, the body 17 is provided with a through hole in which an attachment screw 20 is applied, passing through the hole and securing the sensor 10. The sensor 10 is thus fixed in relation to the body 17 by means of the screw 20, as will be described below. Other attachment means for the sensor 10 are naturally possible. Otherwise, the body 17 preferably has a circular cross section. Further down beneath the sensor, the body 17 assumes a narrowing, flattened shape in an area corresponding to the joint 8, mentioned earlier, and described in conjunction with figures 2, 3a and 3b.

The sensor 10 and the body 17 are arranged inside a protective casing 22. This casing has an opening at the top, adjacent to the surrounding refining segment, which is closed by the measuring surface 7, a seal 12 surrounding the measuring surface, and a sleeve 13 in which the seal is arranged. The seal 12 is of a particularly suitable, somewhat yielding material such as rubber, so that it can permit the small movements that the shear forces give rise to in the measuring surface, and still achieve a good seal that prevents steam and pulp from penetrating into the device. The seal preferably has a dampening effect as regards, inter alia, the vibrations that occur during operation. The purpose of the sleeve 13 is primarily to facilitate sealing of the measuring device since the measuring surface and the seal are first assembled in the sleeve which can then easily be inserted partially into the casing 22. Naturally, it is possible to omit the sleeve.

The casing 22 also has a function in securing the sensor 10 in relation to the measuring surface 7. The sensor is thus secured in the casing by means of the attachment screw 20. Finally, the body 17 is attached in the casing at the end opposite to the measuring surface.

The invention is not limited to the embodiment illustrated in the drawings. It can be modified and altered in many ways obvious to one skilled in the art, within the scope of the appended claims.

CLAIMS

1. A method for measuring stress forces in refiners having refining discs that between them define a refining gap for refining material between bars (3) arranged on the refining discs, **characterized** in that measurement is performed across a measuring surface (7) constituting a part of a refining disc, said measuring surface comprising at least parts of more than one bar (3) and being resiliently mounted in relation to the surface of the refining disc.

2. A method as claimed in claim 1, **characterized** in that measurement is performed by the measuring surface being resiliently journalled in a direction parallel with the surface of the refining disc and being movable in said direction in the event of a stress force, in relation to a permanently inserted force sensor with which the measuring surface is connected, said force sensor thus being influenced by and measuring said stress force.

3. A method as claimed in claim 1 or claim 2, **characterized** in that the size and distribution of the output transferred to the material are calculated on the basis of the measured stress forces and that these calculations are then used to control the refining process.

4. A measuring device for measuring stress forces in refiners comprising refining discs that between them define a refining gap for refining material between bars (3) arranged on the refining discs, **characterized** in that said device comprises members (10) that measure the stress force across a measuring surface (7) constituting a part of a refining disc, in that said measuring surface comprises at least parts of more than one bar (3) and being resiliently mounted in relation to the surface of the refining disc.

5. A measuring device as claimed in claim 4, **characterized** in that it comprises a force sensor (10) and a body (17) that connects said sensor to the measuring surface (7).

6. A measuring device as claimed in claim 5, **characterized** in that the force sensor (10) abuts said body (17) while at the same time being fixed in relation to said body by means of attachment means (20).

7. A measuring device as claimed in claim 6, **characterized** in that it comprises members (12, 17) for resilient journalling of the measuring surface in a direction essentially parallel with the surface of the refining disc.

8. A measuring device as claimed in claim 7, **characterized** in that the measuring surface (7) is connected to said body (17) and in that, furthermore, the part of said body that extends on the side of the force sensor (10) opposite to the measuring surface, is provided with a joint (8) where the body is movable in a direction substantially parallel with the surface of the refining disc.

9. A measuring device as claimed in claim 8, **characterized** in that the body (17) is substantially circular in cross section and that the joint (8) is formed by a part of the body, located below the force sensor (10), being flattened.

10. A measuring device as claimed in any of claims 5-9, **characterized** in that the force sensor (10) is a piezoelectric sensor.

11. A measuring device as claimed in any of claims 4-10, **characterized** in that said measuring surface (7) constitutes a part of the measuring device and that the measuring surface is surrounded by a sealing member (12) by which it is joined to surrounding parts of the measuring device, and which sealing member (12) is made of a somewhat yielding material.

12. A measuring device as claimed in claim 11, **characterized** in that it comprises a casing (22), that the force sensor (10) and the body (17) are arranged inside said casing, that the force sensor is attached inside the casing by means of said attachment means (20) and is thus secured in relation to said body, that one end of the body, opposite to the end joined to the measuring surface, is secured in the casing and that the casing is closed by means of the measuring surface (7) and the sealing member (12).

13. A measuring device as claimed in claim 12, **characterized** in that the sealing member is arranged in a sleeve (13) which sleeve, with the sealing member (12) and measuring surface (7), is inserted in the casing (22) in order to seal the casing.

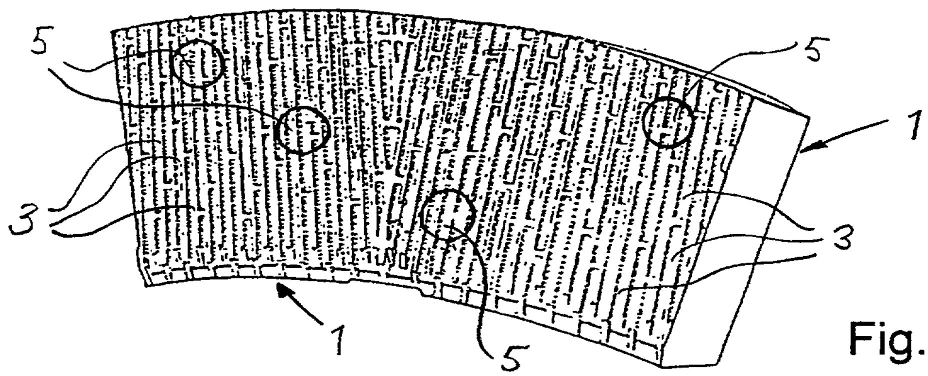

Fig. 1

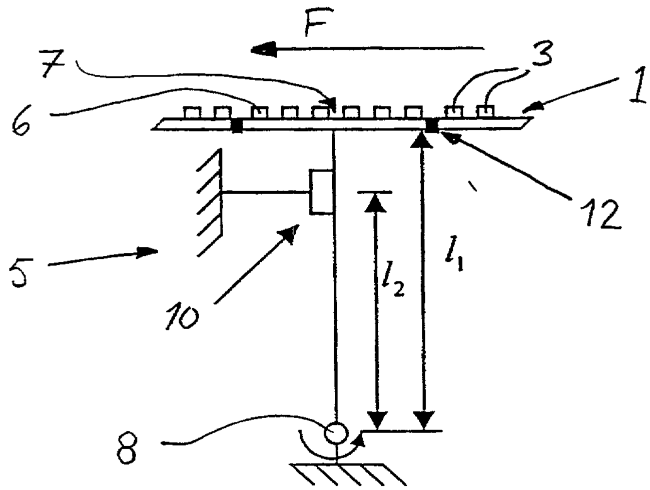

Fig. 2

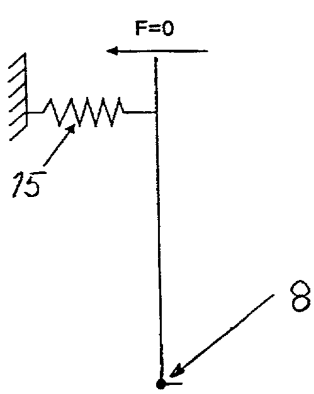

Fig. 3a

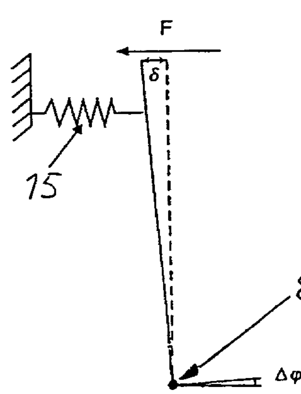

Fig. 3b

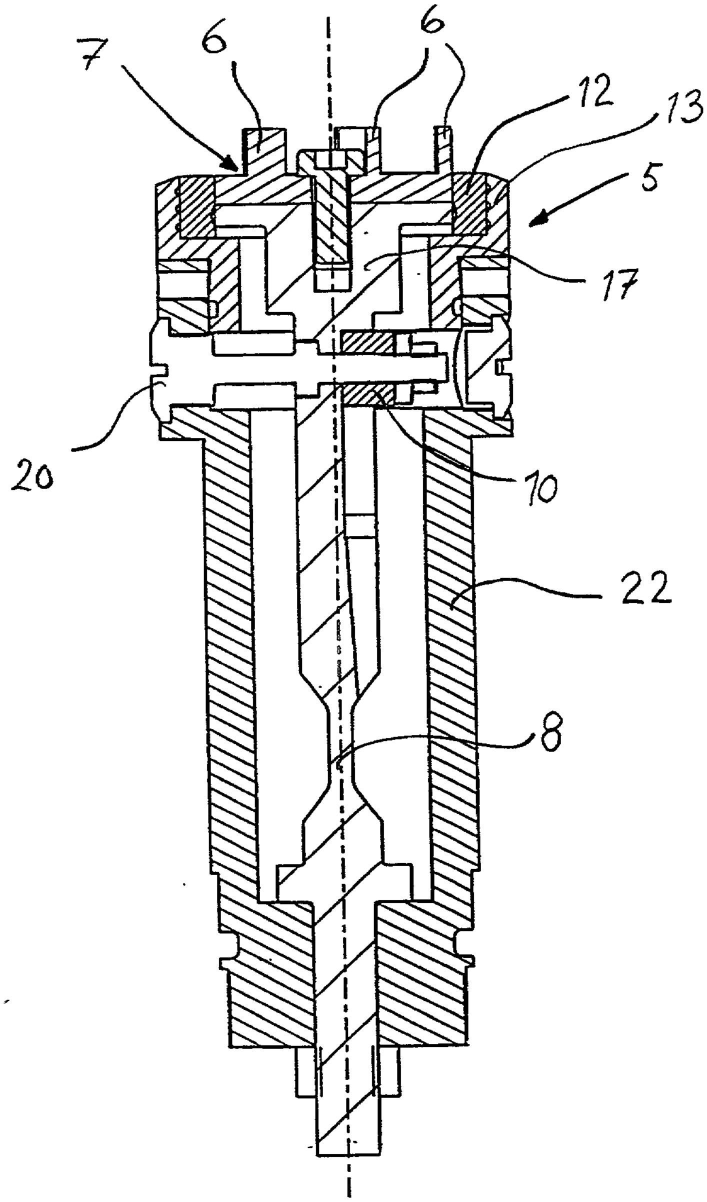

Fig. 4

DECLARATION FOR UTILITY OR DESIGN PATENT APPLICATION

ATTORNEY'S DOCKET NO.: LAGROTH-028

As a below-named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name;

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled: A METHOD AND MEANS FOR MEASURING STRESS FORCES IN REFINERS, the specification of which

☐ is attached hereto

☒ was filed on 15 June 2000 as United States Application Number or PCT International Application Number PCT/SE00/01257 and was amended on ______ (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment specifically referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, § 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, § 119(a)-(d) of any foreign application(s) for patent or inventor's certificate, or § 365(a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below any foreign application for patent or inventor's certificate, or any PCT international application having a filing date before that of the application on which priority is claimed:

PRIOR FOREIGN APPLICATION(S)

COUNTRY	APPLICATION NUMBER	DATE OF FILING (month, day, year)	PRIORITY CLAIMED
Sweden	9902306-1	17 June 1999	YES ☒ NO ☐
			YES ☐ NO ☐
			YES ☐ NO ☐

LISTING OF FOREIGN APPLICATIONS CONTINUED ON PAGE 3 HEREOF ☐ YES ☒ NO

I hereby claim the benefit under Title 35, United States Code, § 119(e) of any United States provisional application(s) listed below:

Application Number: ______ Filing Date: ______

Application Number: ______ Filing Date: ______

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s), or § 365(c) of any PCT international application designating the United States of America, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT international application in the manner provided by the first paragraph of Title 35, United States Code, § 112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, § 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application:

U.S. Parent Application Serial Number: ______ Parent Filing Date: ______ Parent Patent No.: ______

U.S. Parent Application Serial Number: ______ Parent Filing Date: ______ Parent Patent No.: ______

PCT Parent Number: ______ Parent Filing Date: ______

LISTING OF US APPLICATIONS CONTINUED ON PAGE 3 HEREOF: ☐ YES ☒ NO

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following registered practitioner(s) to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith.

Lawrence I. Lerner, Reg. No. 19,516; Sidney David, Reg. No. 22,768; Joseph S. Littenberg, Reg. No. 20,832; Arnold H. Krumholz, Reg. No. 25,428; William L. Mentlik, Reg. No. 27,108; John R. Nelson, Reg. No. 26,573; Roy H. Wepner, Reg. No. 28,350; Stephen B. Goldman, Reg. No. 28,512; Paul H. Kochanski, Reg. No. 28,680; Marcus J. Millet, Reg. No. 28,241; Bruce H. Sales, Reg No. 32,793; Daniel H. Bobis, Reg. No. 16,694; Peter J. Butch III, Reg. No. 32,203; Keith E. Gilman, Reg. No. 32,137; Robert B. Cohen, Reg. No. 32,768; Arnold B. Dompieri, Reg. No. 29,736; Michael H. Teschner, Reg. No. 32,862; Jeffrey S. Dickey, Reg. No. 35,858; Gregory S. Gewirtz, Reg. No. 36,522; Jonathan A. David, Reg. No. 36,494; Shawn P. Foley, Reg. No. 33,071; Robert T. Canavan, Reg. No. 37,592

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further, that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

100 Full name of sole or first inventor (given name, family name): Hans-Olof Backlund

Inventor's signature Hans-Olof Backlund **Date** 30 Nov. 2001

Residence: Sundsvall, Sweden SEX **Citizenship:** Swedish

Post Office Address: Bågevägen 43 D, S-856 52 Sundsvall, Sweden

200 Full name of second joint inventor, if any (given name, family name): Esko Härkönen

Second Inventor's signature Esko Härkönen **Date** 30 Nov. 2001

Residence: Kajaani, Finland FIX **Citizenship:** Finnish

Post Office Address: Jauhokalliontie 1 E 14, FIN-87200 Kajaani, Finland

Full name of third joint inventor, if any (given name, family name): ______

Third Inventor's signature ______ **Date** ______

Residence: ______ **Citizenship:** ______

Post Office Address: ______

Full name of fourth joint inventor, if any (given name, family name): ______

Fourth Inventor's signature ______ **Date** ______

Residence: ______ **Citizenship:** ______

Post Office Address: ______

Full name of fifth joint inventor (given name, family name): ______

Fifth Inventor's signature ______ **Date** ______

Residence: ______ **Citizenship:** ______

Post Office Address: ______

Full name of sixth joint inventor, if any (given name, family name): ______

Sixth Inventor's signature ______ **Date** ______

Residence: ______ **Citizenship:** ______

Post Office Address: ______

Full name of seventh joint inventor, if any (given name, family name): ______

Seventh Inventor's signature ______ **Date** ______

Residence: ______ **Citizenship:** ______

Post Office Address: ______

Full name of eighth joint inventor, if any (given name, family name): ______

Eighth Inventor's signature ______ **Date** ______

Residence: ______ **Citizenship:** ______

Post Office Address: ______

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